mits in itself no other mathematical comparison than that of equality and inequality, and no other mathematical treatment than simple increase or decrease, and in consequence it does not admit directly of ordinary mathematical investigation. Number and extended magnitude, such as length, duration, &c., admits of comparison by ratio, and of addition, subtraction, multiplication, division, &c. Magnitudes of degree are only brought under mathematical processes by means of conventional measurement. That is to say, some number or extended magnitude, which is found by experience to vary with the magnitude of degree, is adopted eventually as the measure of that magnitude, and mathematical processes are applied to the measure. It is incorrect, however, to say that we take an extended magnitude which varies in direct proportion with the magnitude of degree, as its measure, because direct proportion of magnitudes which vary together involves inequality of ratio of corresponding value, and, as already stated, the proportion of ratio does not really subsist between different values of a magnitude of degree, though from the intimate mental connection between certain magnitudes of degree and their measures, we often think it does.

When, for instance, we say that the brightness of two equal lights is double that of either, the statement is quite incapable of proof by experiment, and is certainly not intuitional; it is simply conventional. If we agreed that the brightness of a number of equal lights should be measured by the square root of the number, we should have to consider that the brightness of light varies inversely as its distance instead of as the square of its distance from its origin,—a result against which nothing could be urged but its practical inconvenience. Or, to take the example of a magnitude of degree whose conventional movement is somewhat less familiar to our minds: when we say that our expectation of an event which happens on an average three out of four times is double of our expectation of an event which happens once out of four times, we are clearly using words in a conventional way. The one belief is not really double of the other, but the average by which we agree to measure it is double.

Now with respect to force and mass, both magnitudes of degree, it so happens that there are two almost equally natural methods of measuring them consistent with, but nevertheless independent of, each other. Each of these may be conventionally adopted, but in either case its consistence with the other can only be demonstrated by experiment.

If you agree to measure force as directly proportionate to the acceleration it produces on a given mass, and mass as inversely proportionate to the acceleration produced by a given force, then, to that extent, the second law of motion, and the law which is sometimes adopted in place of Newton's third, are the results neither of experience nor intuition, but simply of convention; but then, on the other hand, it must be held that it is by experience we come to the conclusion that the mass of two bodies, *as above measured*, is the sum of their two masses, and the weight of two bodies the sum of their weights. If, on the other hand, you conventionally measure forces by the number of equal weights which will produce the same effect, and masses by the number of bodies of equal mass which make them up, then clearly the truth of the above portion of the laws of motion can only be proved by experience.

The mistake made by some mathematicians is that while ostensibly assuming the one conventional measure of force and mass they tacitly assume the other, and then illogically profess to demonstrate the necessary consequences of their own conventions by reference to experience founded on the other. They agree to measure force by the acceleration it produces in its own direction on a given mass, and then profess to prove forces do produce such proportionate acceleration by reference to experience, on the assumption that forces are to be measured by the number of equal weights or other forces which will produce the same effect.

In the case of the first law of motion, mathematicians often commit an error even more flagrant. To define force as that which affects motion, and then to profess that it is proved by experience that a body acted on by no force will remain at rest or move uniform, is on the face of it absurd. As well might Euclid, after defining a circle, have appealed to experience to show that a figure, every point of whose circumference is not equally distant from the centre, is not a circle. Or as well might a doctor begin by defining intoxication to be a state produced by taking alcohol, and then appeal to the experience of the Good Templars to prove that in the absence of alcohol there is no intoxication.

Herbert Spencer seems to me to be wrong, therefore, in concluding that our belief in the laws of motion is in the true sense (if it has any true sense) intuitive; but his error is the more excusable on account of the confusion of ideas involved in most mathematical explanations of these laws.

F. GUTHRIE

Graaff Reinet College, Cape of Good Hope, June 21

ORGANISATION OF THE FRENCH METEOROLOGICAL SERVICE

THE measures we alluded to in NATURE, vol. x. p. 294, with respect to the French Meteorological Service, have been partially adopted, and will be shortly followed by others. The Meteorological Service has been divided between two astronomers—M. Rayet, who has under his special care the magnetical map of France, the official observations taken at the observatory, and the several French stations; and M. Froat, who has been appointed to investigate the great disturbances of the atmosphere, to send warnings to the principal French seaports, to publish the atlas, and correspond with the several departmental commissions which have been already appointed. These departmental commissions are appointed by the prefect of each department, and funds are granted to them out of the departmental budget and voted by the Council-General of each department.

M. Leverrier issued, on August 5, a circular to these general commissions, informing them that the printing of the storm-maps, which had been stopped owing to the country's calamities, was to be resumed.

Special mention is made in this circular ot the hailstorms which have been studied most carefully by MM. Becquerel, father and son. Nothing has been done yet to increase the efficiency of lightning conductors.

The several departmental commissions, numbering about ninety, including Algiers, have been grouped into six natural regions. M. Ch. Sainte-Clair Deville has been sent to Algiers to organise the meteorology of that country, from the sea to the remotest parts of the French possessions in the desert. He has not finished his tour yet. He is General Inspector for Meteorology, and had issued an order for altering the hours of observation, which order was cancelled by the Ministry.

Some arrangements have yet to be made with the navy for the storm warnings. Very likely French seaports will continue to receive warnings from England, which are very popular, as well as warnings from their own observatory.

NOTES

MR. BRIAN HODGSON, F.Z.S., has presented to the library of the Zoological Society a large collection of original drawings of Himalayan Mammals, made during his residence in Nepaul. They are of much scientific value, as being in many cases taken from the types on which his species are founded.

M. MAREY has recently published the results of experiments undertaken to determine by the graphic method what is the true movement of the legs in walking. His results prove convincingly that the brothers Weber were wrong in assuming that the oscillation of the leg which is not in contact with the ground is the same as that of a pendulum; for when it is represented on a uniformly moving plane, the line drawn is a straight and not a curved one. The movement of the suspended foot is therefore uniform, depending on muscular action, in combination with that of gravity.

DR. MORRISON WATSON, Senior Demonstrator of Anatomy in the University of Edinburgh, has been appointed Professor of Anatomy in the Owens College, Manchester.

A PARTICULARLY closely reasoned and valuable paper has just been published by Dr. William Marcet, F.R.S., entitled "An Experimental Inquiry into the Nutrition of Animal Tissues," in which the author argues out, and substantiates by careful analysis, his division of the constituents of animal tissues into the parts which constitute the working or ripe tissue, insoluble in water; the nutritive material of the tissue, colloid and soluble; and the products of tissue-destruction, crystalloid and soluble. We hope to be able to give an abstract of this paper on a future occasion.

Les Mondes announces the death, on July 21, of Count Gustave Doulcet de Pontécoulant, who was born in 1798.

THE seventh session of the International Congress of Anthropology and Prehistoric Archæology was closed at Stockholm on Sunday, after having fixed on Buda-Pesth as the next place of meeting. The number of members of this Association is upwards of 1,550: of these, 800 were present at the Stockholm meeting, which commenced on the 7th instant, when the following officials were chosen :—Patron, Oscar II., King of Sweden and Norway; president, Count Hammig Hamilton, Grand Chancellor of the Swedish Universities; honorary presidents, MM. Desor, Capellini, and Worsaae; vice-presidents, MM. Hildebrandt, sen., and Nilsson (Sweden), De Quatrefages (France), Franks (England), Virchow (Germany), Dupont (Belgium), Leemans and Bogdanow (Russia); general secretary, M. Hans Hildebrandt; secretaries, MM. Montelius, Retzius, Chantre, and Cazalis de Fondouce; assistant secretaries, MM. Stolpe and Landberg; council, MM. Bertrand, Berthelot, Evans, Von Quast, Schaffhausen, Pigorini, Van Beneden, Engelhardt, Rygh, Von Düben, Aspelin, Lerch, Romer, Whitney. The sittings were held at the *Riddarhus*, or "House of Knights," a house as old as the time of Gustavus Adolphus, which belongs to the Swedish nobility. Stockholm was very appropriately fixed upon as the place of meeting for this year's Congress, as the northern antiquaries and archæologists have done a great deal to form the departments of research with which the Congress deals; we need only mention the names of Bruzelius, Thomsen (Denmark), Nilsson, Retzius, and Hildebrandt. The magnificent museum of Stockholm was commenced in 1850, and finished in 1863, and the collection has been arranged by the Government Antiquary, M. Hildebrandt, and is one of the finest collections of prehistoric archæology in existence. Both the King and the city of Stockholm gave the antiquaries a splendid welcome.

THE British Medical Association meets next year in Edinburgh, the president-elect being Prof. Sir Robert Christison, Bart.

A NEW physiological laboratory, and also an addition to the chemical laboratory of Westminster Hospital, are rapidly approaching completion.

AT the meeting of the Paris Academy of Sciences on the 10th inst., a letter from the Minister of Public Instruction was read, informing the Academy that in consequence of the proposition made to the National Assembly in the month of July last to establish in the neighbourhood of Paris a Physical Observatory independent of the Astronomical Observatory, it was decided to consult the Academy as to the appropriateness and utility of such an establishment. The Minister requested the Academy to consider the question and let him know what conclusion they came to.

WITH reference to Prof. Newcomb's investigation of the moon's motion, the superintendent of the U.S. Naval Observatory reports that the work has been nearly accomplished and prepared for the press according to the original plan; but on examining certain terms troublesome to calculate, which it was supposed were entirely unimportant, it was found that the work could not be properly completed without them. The preparations for observing the transit of Venus have interfered with the development of these important terms. The second part of the work, namely, the tables founded upon Prof. Newcomb's theory, has been carried as far as it can be without the data that will be attainable as soon as the preparations for observing the transit of Venus are completed.

ADMIRAL SANDS, in his annual report with reference to the work of the U.S. Naval Observatory, states that observations, to be of any value to the world, must be published. If they are not, the time and labour spent upon them are simply wasted; and yet they are so much more easily made than reduced, that nothing is more common than to see them lie for years before the computations necessary to fit them for publication are completed. The Naval Observatory has been enabled to resuscitate from its store-rooms the zones of stars observed by Capt. Gilliss, in Chili, in 1850-52, and their reductions are now in such a state of forwardness that the resulting star catalogue will appear in the volume of Washington Observations for 1873. Thus it will be seen that nearly all the valuable observations which were at one time locked up in the archives of the observatory have been given to the world.

WE notice with much pleasure that the Society of Arts has issued a prospectus of Examinations in the Technology of Agriculture and Rural Economy, proposed to be held annually by the Society, as a part of its excellent system of technological examinations in the various industries of the country. We sincerely hope that the proposed examinations will be largely the means of carrying out the object which the Society has in view in instituting them, viz., the promotion of a more extended and intelligent study of agriculture and of the sciences bearing upon it, by those intending to adopt farming as an occupation. The examinations will consist of three parts :—(1) General Science, in which a very wide knowledge of the various sciences which lie at the basis of successful agriculture is demanded from the candidates; there are three certificates in this department—the Elementary Certificate, the Advanced Certificate, and Honours. (2) Technology, in which a knowledge of the many points connected with agriculture and rural economy will be demanded from the candidates proportioned to the class in which they may have passed in the previous examinations; this examination looks very formidable on paper, and to pass creditably in it will demand extensive reading and hard work on the part of the candidates. (3) Practical Knowledge: under this head the candidate must forward to the Society of Arts a certificate, on a form supplied, signed by some agriculturist with whom he may have been practically engaged in farming operations, showing that he has a practical acquaintance with the subject. In order to render these examinations really useful, the Council are making application to the Agricultural Societies, local and general, for assistance in founding scholarships for successful candidates to undergo a regular course of instruction at an Agricultural College. We hope the scheme of the Society of Arts will be productive of excellent results on the agriculture of the country.

M. RÉNAN has brought out a new work, "La Mission de Phénicie," being an account of the scientific researches in Syria during the sojourn of the French army in 1860-61.

A COMMITTEE has been formed to consider what means ought to be taken for the construction of an aquarium at Herne Bay.

PROF. GERVAIS (U.S.) has made a communication upon the teeth of the American reptile known as *Heloderma*. A species of the genus is abundant in Southern Arizona, where it is called a scorpion, and is reputed by the natives to be extremely venomous, although experiments carefully prosecuted by Dr. B. J. D. Irwin, of the United States army, failed to exhibit any evidence of this fact. There is, as Gervais and others have found, a striking relationship between it and some of the poisonous serpents in the possession of a longitudinal furrow on the back part of the teeth, as if to carry poison from a gland. Whether the animal be actually poisonous or not, Gervais calls attention to the peculiar structure of the teeth (as shown by the microscope in a cross section), the basal part of which is filled by folds or plications directed outward toward the fine exterior coat of enamel.

Two new medical bi-monthly journals come to us from Paris; one, the *Paris Medical Record*, is in English, and in general appearance and arrangement resembles the *London Medical Record*; its declared intention is to supplement the efforts of other medical journals. The other, *Echo de la Presse Médicale*, is intended as the complement of the above, and is to be published every alternate week.

THE Wheeler U.S. expedition started from Washington to concentrate at Pueblo, Colorado, on July 15, leaving there as soon thereafter as the different parties can be got into shape. It will move in three separate divisions, which will occupy portions of South-western Colorado and Northern New Mexico. The principal localities to be examined are south of the thirty-eighth parallel of north latitude, in the neighbourhood of the Rio San Juan, and the northern tributaries of the Rio Grande, Rio Chamas, Pecos, and Canadian, a region extremely interesting, and which must shortly be opened up for mining purposes. There will be two separate astronomical parties, one in charge of Mr. John H. Clark, with one assistant, at the observatory, Ogden, Utah; the other in charge of Dr. F. L. Kampf, who will have two assistants, and will occupy stations at Las Vegas, Cimmaron, Sidney Barracks, Julesburgh, and the crossing of the Union Pacific Railroad at the one hundredth meridian. In New Mexico there will be a special party operating, consisting of Prof. E. D. Cope, palæontologist, and Dr. H. C. Yarrow, naturalist of the survey, and one assistant. These gentlemen will visit certain specified areas in the valley of the Rio Grande and Rio San Juan. The main division will be in charge of Lieut. Wheeler, assisted by Lieut. C. W. Whipple and six civilian assistants. The first party of the first division will be in charge of Lieut. W. L. Marshall, assisted by three civilian assistants. The second party consists of Lieut. Rogers Birnie and five civilian assistants. The second division of the first party, Lieut. P. M. Price and four civilian assistants; second party, Lieut. S. E. Blunt and three civilian assistants. There is also a special natural history party, at present operating in portions of Arizona and New Mexico, consisting of Dr. J. T. Rothrock, botanist, Prof. H. W. Henshaw, ornithologist, and James Rutter, general collector. Dr. Oscar Loew will acompany the expedition as chemist and mineralogist, and will be assigned to one of the above-named sections. The entire expedition is made up of nine different parties, and will cover a wide and interesting field; and it is hoped that our geographical knowledge, in the broadest sense of the word, will be greatly augmented by its labours and investigations. Mr. Henshaw and his associates of the special party, above referred to, have been heard from in the vicinity of Fort Wingate, New Mexico, where they were making the best of their way south. They have already secured extensive collections of specimens, and a box has been received at the Washington office containing a number of bird-skins, Indian crania, fish, reptiles, insects, plants, &c. This party will proceed south to near the Mexican boundary, and then retrace their steps, disbanding at Santa Fé in the fall.

IN a paper reprinted from the *American Journal of Science and Arts*, On the connection between isomorphism, molecular weight, and physiological action, by James Blake, M.D., the author gives the following results of investigations on the action of substances when introduced into the veins or arteries of living animals:—1. In the changes induced in living matter by inorganic compounds, the character of the change depends more on the physical properties of the reagent than on its more purely chemical properties. 2. That the character of the changes is determined by the isomorphous relations of the electro-positive element of the reagent. 3. That among the compounds of the more purely metallic elements, the quantity of substances in the same isomorphous group required to produce analogous changes in living matter, is less as the atomic weight of the electro-positive element increases. 4. That the action of inorganic compounds on living matter appears not to be connected with the changes they produce in the proximate elements of the solids and fluids, when no longer forming part of a living body, at least in so far as our present means of research enable us to judge. 5. That in living matter we possess a reagent capable of aiding us in our investigations on the molecular properties of substances.

THERE have been found in the Waiora district, Central India, in a coalfield of about 1,000 acres, two seams, one 15 ft. and the other 20 ft. thick, close together. In other parts the seam is from 50 ft. to 60 ft. thick. It is also said there are millions of tons of iron ore yielding 70 per cent. of metallic iron.

AMONG other recent interesting announcements is that by Mr. O. Harger of the discovery in the coal measures of Illinois of a fossil spider, to which the name *Arthrolycosa antiqua* has been applied.

THE telegraphic apparatus at the U.S. Naval Observatory at Washington is now connected with the main lines of the Western Union Telegraph Company, so that not only is the time-ball dropped daily at noon, but the same signal is widely distributed by the telegraph company. It goes directly from the observatory to the main office in New York city, and thence it is sent to nearly every State in the Union. The immediate object of these signals is to furnish accurate and uniform time to the railroads, and throughout the whole of the vast territory in question there is scarcely a train whose movements are not regulated by the observatory clocks. The clocks at the Navy Department, at the Army Signal Office, at the Treasury Department, and at the Western Union Telegraph Company's office are all constructed on the system known as Hamblett's, and are directly controlled by electric currents sent every second by the standard clock at the observatory.

THE additions to the Zoological Society's Gardens during the past week include a Puma (*Felis concolor*), and three Kinkajous (*Cercoleptes caudivolvulus*), from South America, presented by Mr. W. Delisle Powles; a Cuvier's Toucan (*Ramphastos cuvieri*), from Brazil, presented by Mr. Philip Harrington; a Macaque Monkey (*Macacus cynomolgus*), white variety, from India, presented by Sir Andrew Clarke; a West African Python (*Python sebæ*), deposited; a Crested Agouti (*Dasyprocta cristata*), from South America; five common Kingfishers (*Alcedo ispida*), British, purchased.

THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE forty-fourth Annual Meeting of the Association was opened yesterday at Belfast, when Prof. A. W. Williamson resigned the Presidency to Prof. Tyndall, who delivered the opening Address.

As in former years, we are able, by the courtesy of the officers of the Association, to publish this week the Address of the President of the Association, and the Addresses of some of the Presidents of Sections.